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THE STRIPED CUCUMBER BEETLE AND ITS CONTROL

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THE STRIPED CUCUMBER BEETLE is the most important of all our cucumber insect pests and does serious damage to all forms of cucurbits. It is widely distributed east of the Rocky Mountains and is to be found in most fields and gardens.

The adult striped cucumber beetle is about one-fifth of an inch long, yellow, with three stripes running lengthwise of the wing-covers.

The adults, or beetles, attack and injure the plants as soon as they appear, even burrowing down to meet them before they come above ground. They devour the tender stems and leaflets before the plant is fairly started, gnaw the older stems and fruits, and act as carriers of cucurbit diseases. They work rapidly and entire fields may be destroyed in a few days.

The young, known as " worms " or larvæ, although much less destructive than the beetles, injure the plants later in the season by tunneling the roots and underground parts of the stems.

To control this pest and reduce its ravages four methods are employed: Preventive measures, the use of repellent substances, spraying with arsenical insecticides, and good farm practice. These are described fully on pages 10 to 19 and summarized on page 20.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. May, 1919

THE STRIPED CUCUMBER BEETLE[1] AND ITS CONTROL.

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APPEARANCE AND NATURE OF INJURY.

CONSTANT COMPLAINTS are received from many farmers and gardeners of the ravages of the striped cucumber beetle, our most important insect enemy of cucumber, melon, squash, pumpkin, and related crop plants. This little yellow and black striped pest, known locally as "striped bug," "melon bug," and by other names, attacks the plants early in the season when they first appear, or even before they have appeared above ground.

The principal and most obvious injury is that done to the young plants by the first-appearing or overwintered beetles. Frequently these beetles burrow into the ground to meet the plants and afterwards devour the tender stems and leaflets which have not yet fairly started. The work of the beetle on the first leaves and stems of cucumber is shown in figure 1.

FIG. 1.—Young cucumber plants showing severe and characteristic injury by adults of the striped cucumber beetle at end of roots and in the seed leaves.

[1] *Diabrotica vittata* Fab.; order Coleoptera, family Chrysomelidae.

The beetles are destructive to older plants by eating the leaves and by gnawing away and consuming the outer tissues and considerable portions of the stems, and still later by devouring the rinds of the fruits and rendering them unmarketable.

The larvæ, "worms," or young, are the cause of injury later through their work underground in the roots and stems (fig. 2), which they tunnel from below. The larvæ, however, are by no means as destructive as the beetles.

The beetles cause further mischief by acting as carriers of the bacterial wilt [1] of cucurbits. This is a matter of grave importance and has been the subject of special investigation by the Department of Agriculture during the years 1915 to 1918. The beetles are also carriers of cucurbit mosaic.

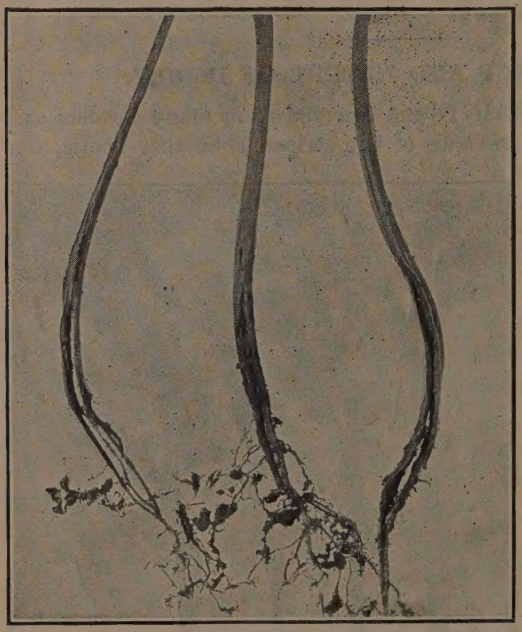

FIG. 2.—Underground stems of cucumber showing injury by larvæ of the striped cucumber beetle.

The underground feeding habits of the larvæ make it certain that more often than not the roots of cucurbits are being honeycombed without the knowledge of the farmer or gardener, the outward manifestation of their presence being the wilting of the leaves and the failure of the plants to develop perfect fruit. Far too often the debility or death of the vines through the work of this insect—the larvæ at the roots and the beetles on the stems near the ground—is attributed, even by expert growers, to wilt, dry weather, or some other than the real cause. Injury, then, is threefold, due (1) to direct attack by the beetles on the plant, (2) indirectly to the beetles as transmitters of diseases, and (3) to the work of the larvæ in destroying the root system.

WHAT THE INSECT LOOKS LIKE IN ITS DIFFERENT STAGES.

In the course of its life this insect passes through four stages of development: (1) The egg, (2) the larva or "worm," (3) the pupa or resting stage, and (4) the adult or beetle.

[1] *Bacillus tracheiphilus* Erw. Sm.

The adult striped cucumber beetle (fig. 3, *a*) is about one-fifth of an inch long and half as much in width. It is yellow above, with black head and black stripes running lengthwise along each wing cover, producing the effect of a three-striped back. The abdomen underneath is black but the neck and legs are yellow and the antennæ, or feelers, are mostly black. The feet and knees are black.

The egg (fig. 3, *d*) is about one-fortieth of an inch in length and about half as wide. In color it is bright lemon yellow to orange. Its surface, as viewed under a high-power microscope, is finely sculptured, arranged in hexagonal pits (fig. 3, *e*).

The larva (fig. 3, *b*) is a very slender, white, wormlike creature, with dark-brown head and anal plate and lighter brown thoracic plate. When fully matured its length is about three-tenths of an

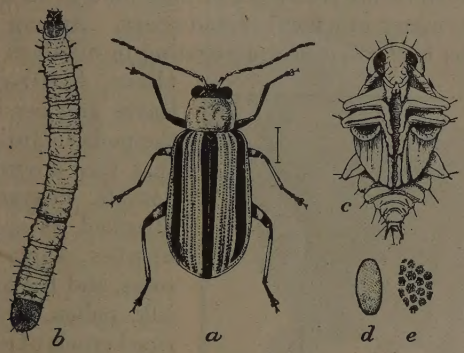

FIG. 3.

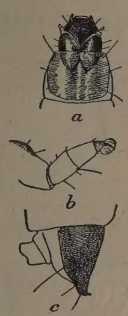

FIG. 4.

FIG. 3.—Striped cucumber beetle: *a*, Beetle; *b*, larva; *c*, pupa; *d*, egg; *e*, sculpture of egg. *a*, *b*, *c*, Much enlarged; *d*, more enlarged; *e*, highly magnified.

FIG. 4.—Striped cucumber beetle: *a*, Head of larva; *b*, leg of same; *c*, last segment from side showing hind false-leg. All greatly enlarged.

inch, this being about ten times its width. It is provided in front with three pairs of thoracic or true legs, and behind with an anal proleg (hind false-leg). Figure 4 shows the head and thoracic plate (*a*), a true leg (*b*), and (*c*) the anal proleg or hind false-leg and anal plate in profile.

The pupa (fig. 3, *c*) is of nearly the same color as the larva and its surface is sparsely beset with long spinelike hairs, those on the upper surface or back arising from small but prominent hair-bearing warts.

WHERE IT OCCURS.

The striped cucumber beetle is native to this country and inhabits all parts of the United States east of the Rocky Mountains from Canada to Mexico. It is not only found wherever cucurbits are grown, but it is able to subsist on wild cucurbits and is injurious in every State and Territory of the Union where it occurs. The approximate distribution is shown in the accompanying map (fig. 5).

ITS FOOD PLANTS.

The striped cucumber beetle is nearly always present in the farm and garden over an area which embraces nearly the whole of North America,[1] and is by far more common and more destructive than any other cucurbit pest with which the farmer and gardener have to deal. Hubbard and marrow squashes are favorite host plants, followed by cucumbers and cantaloupes. Other cucurbits, such as pumpkins, gourds, summer squashes, watermelons, and chayotes are also injured by the beetles and larvæ.

It is not alone in the field and garden that this insect is troublesome, since serious injury is often done in greenhouses by both beetles and larvæ.

So far as known, the larvæ are restricted in their food to cucurbits, but the beetles attack many other cultivated crops. Among these beans are favorites, the beetles often congregating in numbers upon them, killing the leaves and rendering the pods so unsightly that they are unmarketable. Peas are also attacked, as are ripe apples, apple blossoms, and the leaves, silk, pollen, and unripe kernels of corn.

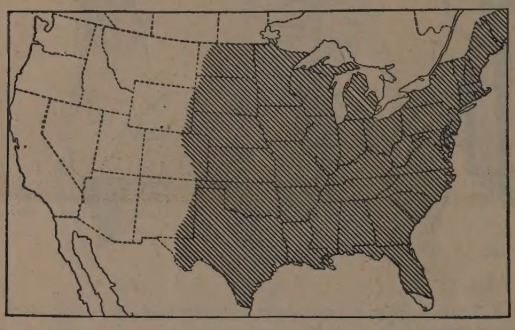

FIG. 5.—Map showing approximate distribution of the striped cucumber beetle in the United States.

The beetles naturally are flower feeders and may be found on the large blossoms of the squash and pumpkin as long as they are in bloom. Notwithstanding this, they eat nearly every other portion of a plant, and frequently cause injury to cucurbits by gnawing the rinds of the fruit, thus rendering them unfit for market. (See figs. 6 and 7.)

Among wild plants the beetles are partial to the flowers of goldenrod, aster, and sunflower, in late summer and autumn, devouring the colored portions, stamens, pistils, and ray flowers. In the spring they frequent the flowers of chokeberry, Juneberry, cherry, and related plants. They feed freely on the prickly cucumber or wild balsam apple,[2] a plant cultivated for ornament and shade, but also a favorite natural food plant of this insect, and on the great ragweed.[3]

[1] In the Pacific States it is replaced by a very closely related species known as the western striped cucumber beetle (*Diabrotica trivittata* Mann.).

[2] *Micrampelis* (*Echinocystis*) *lobata*.

[3] *Ambrosia trifida*.

The beetles make their first appearance on these plants in Iowa, Indiana, and Wisconsin in late May and early June.

LIFE HISTORY AND HABITS.

The beetles are abroad in the principal trucking sections in April or May, earlier or later according to locality and climate, feast on such flowers as may be in season, on wild cucumber, the great ragweed, and other vegetation, and when cucumbers and other cucurbits are set out attack and injure them in the manner previously described.

FIG. 6.—Striped cucumber beetles feeding on cucumbers after frost has killed the foliage. Natural size.

The female beetles lay their eggs, either singly or in groups, in the soil about the roots and stems, frequently placing them in cracks and crevices. The number deposited by a single beetle varies, 1,457[1] being the highest number observed and 400 or 500 the average. The eggs hatch in from one to two weeks, the egg period being shorter when the weather is warm.

The larval period is passed in earth that is somewhat moist, about the base of the stalks, and larvæ may be found within the stems and on the fruit where this comes in contact with the earth. This period lasts from two to five and one-half weeks, according to temperature; in July, 1918, at Plymouth, Ind., it lasted three weeks on an average. Hence there is an active stage of this duration in which the larvæ working in numbers have ample time for injuring the roots and stems.

When full grown, just before changing to the pupa, the larva contracts and becomes much stouter. Larvæ observed by the writer in July remained for three days in this condition, which is the usual warm-weather quiescent period preceding the change to the pupa.

[1] Reported by M. R. Smith and J. M. Craig at Plymouth, Ind., August, 1918.

In Indiana this preliminary period lasts from two to five days. The pupal period varies with climate and season, being from five to eight days in length in warm weather and sometimes as much as two weeks long when it is colder.

Adults of the new or first generation begin to develop as early as the first week in July and continue to appear for several weeks thereafter. The first appearing or overwintered beetles begin to die at about the end of July, so that there is some overlapping of the two generations.

The entire life cycle covers from five and one-half to eight weeks, but in tropical southern Texas it may be passed in less than four weeks. In the District of Columbia it occupies about six weeks.

FIG. 7.—Ripe watermelon injured by striped cucumber beetle.

NUMBER OF GENERATIONS ANNUALLY.

Only one generation of the striped cucumber beetle annually has been observed in the more northern States. Farther south there are probably two or, exceptionally, three, and in tropical Texas there may be even four. In the Middle Atlantic States newly transformed beetles have been observed from the second week in July until the first week in October.

HIBERNATION.

Toward the end of the season, during September and October, in the principal trucking regions, the beetles congregate under the vines and prostrate portions of plants, withered leaves, and abandoned fruits of cucumber, melons, squash, and other cucurbits, hundreds of individuals sometimes gathering on a single plant. Frequently they assemble in great numbers on melons and eat off the rind. They also attack beans and destroy them for market. After feeding freely they seek various places of shelter.

During the first cold nights of October the beetles begin to disappear in the District of Columbia, although hibernation may commence earlier. Just when this usually takes place, and where, has not been determined very definitely, but it has been learned during the past two years, in the three States of Iowa, Indiana, and Wisconsin,

where this insect has been under observation, that the principal place of hibernation is along river bottoms and in dense weeds found in such locations. Judging from the fact that the beetles are first seen on wild cucumber and on the great ragweed in such locations, it is evident that they hibernate in the vicinity of these plants. An ideal spot for hibernation, where the insects have been found in great numbers, is shown in figure 8.

NATURAL ENEMIES.

The striped cucumber beetle has at least two important insect enemies, and several others have been observed. The adult or

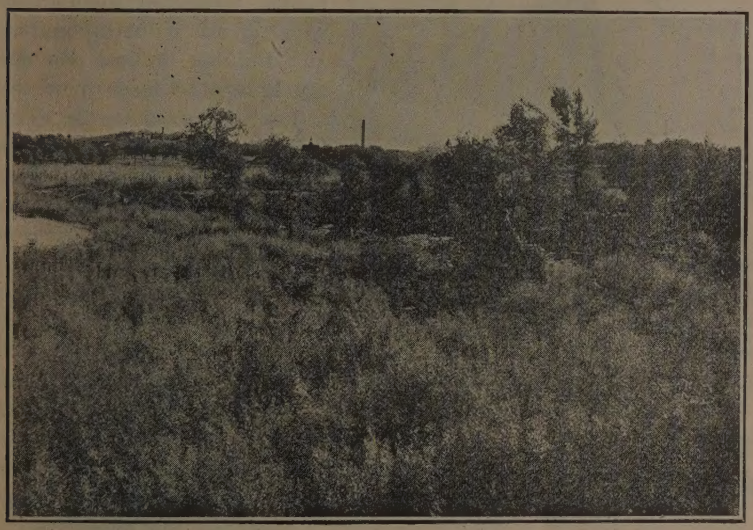

FIG. 8.—Ideal hibernation grounds for the striped cucumber beetle.

beetle is frequently destroyed by two species of parasitic tachina flies which rupture the abdomen of the host when they escape. The first of these [1] has been known for many years and is widely distributed. The second [2] (fig. 9) closely resembles the former and has been detected and described more recently. Its habits are similar.

Three kinds of predatory bugs have been observed attacking the beetle. They destroy them by inserting their beaks in a vulnerable spot and kill them by injecting a poisonous fluid and by sapping their life blood. Two of these [3] are enemies of the Colorado potato beetle. The third species,[4] found rather commonly in this country, is smaller than the others.

[1] *Celatoria diabroticae* Shimer.
[2] *Chaetophleps setosa* Coq.
[3] *Sinea diadema* Fab. and *Perillus bioculatus* Fab. (fig. 10).
[4] *Nabis ferus* L.

A common kind of ground-beetle [1] has been observed repeatedly destroying the striped cucumber beetle in Indiana, but is not an important factor in holding this pest in check.

FIG. 9.—A fly parasite of adult striped cucumber beetles. Much enlarged.

Another enemy, a mite,[2] develops more frequently when the plants attacked are grown under glass and especially when in cold frames. These mites when abundant fasten themselves to the body of the beetle, rendering locomotion very difficult, if not impossible.

A number of bird enemies are known to feed upon the striped cucumber beetle. The following list has been furnished by the Bureau of Biological Survey: Nighthawk, phœbe, wood pewee, yellow-bellied flycatcher, gray flycatcher, least flycatcher, redwinged blackbird, starling, chewink, rose-breasted grosbeak, black-headed grosbeak, Carolina wren, hermit thrush, robin, and bluebird.

Two parasitic fungi destroy this insect.[3]

FIG. 10.—Double-eyed assassin bug, a predacious enemy of the striped cucumber beetle. Much enlarged.

HOW TO CONTROL THE STRIPED CUCUMBER BEETLE.

PREVENTIVE METHODS.

There is no specific remedy for the striped cucumber beetle. Direct applications of poisons will destroy the beetles when they occur in moderate numbers but have not proved entirely effective when they are very abundant; hence, recourse must be had to preventives, deterrents, and cultural methods.

Since the larvæ live in the roots and main stems, principally underground, it is difficult if not impossible to destroy them by any

[1] *Pterostichus lucublandus* Say.

[2] *Uropoda* sp., a parasitid.

[3] They are *Metarrhizium anisopliae* Metsch. and *Beauveria globulifera* Pic. The former attacks the beetles; the latter, the larvæ.

insecticide or other substance which would not at the same time injure the plants.

COVERING YOUNG PLANTS.

To prevent injury to young plants in the home garden early in the season coverings are used. A cheap frame may be made by cutting barrel hoops in two so as to form two semicircles which are then placed at right angles to each other and the ends inserted into the ground. Two strong wires bent in the form of croquet arches can be used for this purpose. The frame is covered with gauze or similar material of close mesh so that the beetles can not work through it and is held in place by earth packed about the edges to prevent the beetles from getting under it. It is necessary to keep the plants covered only while they are young, and the same cover, if properly cared for, may serve a second year. Dish covers of wire gauze, such as are used for the protection of food from house flies (fig. 11) serve the same purpose. When removed from the field they should be stored in a dry place, otherwise the gauze soon rusts.

FIG. 11.—Wire cover for protecting plants against the striped cucumber beetle.

The forms of covering just advised appear to be the ones most easily prepared, most available, and most serviceable. *It is an absolute necessity that the covering employed should be made to fit tightly to the ground at every point to prevent the beetles from burrowing underneath.* These coverings can be used only when the plants are sown in hills. Where cucumbers are sown in drills, such repellents as tobacco dust and lime or other methods of protection are necessary. Finally, considering all the difficulties involved in the use of coverings, a serious one of which is the occurrence of severe rainstorms, the grower must not expect too much from this method.

PLANTING AN EXCESS OF SEED.

If an excess of seed is planted, the attack of the beetles will be less concentrated and severe, and after the first danger period is passed the plants in each hill can be thinned out to the desired number.

A method which has furnished good results in some regions consists in planting the seeds in squares, one each week as shown in the diagram. The first planting (1) is frequently killed, and this may be the fate of the second (2), and sometimes even of the third (3). As long as the insects are seen they are poisoned, and this is continued until a stand of plants is obtained, as it is seldom that all four plantings are destroyed.

CLEAN CULTURE AND TRAP PLANTS.

Injury from this as well as other cucurbit insects will be prevented largely by closer attention to clean methods of cultivation. As soon as a crop is harvested the vines and other remnants should be raked into piles, covered with straw or other inflammable material, and burned. It is advisable, however, to leave standing here and there throughout the fields a few plants, such as those that might be desired for seed, upon which the insects that have not been reached by the fire may concentrate. Here the beetles can be easily destroyed with a spray of strong kerosene emulsion or an arsenical. As traps for the last or hibernating generation, it is well to plant later or to use later varieties. If the beetles are destroyed at this time with lead arsenate or other means, the numbers for the ensuing year will be greatly diminished. The active cooperation of all melon and cucumber growers in the destruction of the fall brood of beetles would accomplish much in a few years.

Some exemption from injury may be secured by growing plants which appear earlier than cucurbits and which supply the beetles with food; for example, beans in connection with cucumbers, in alternate rows. The beans are planted before the cucumbers, the beetles congregate on the bean plants and, being provided with an abundant food supply, are not forced by hunger to attack the young cucurbits. Late beans, also, attract the beetles after the cucurbit crop has been made.

Any cucurbit may be planted as a trap crop. Early cucurbits, such as gourds, planted in the vicinity of later cucumbers and melons, act successfully as traps when the beetles are abundant. Pumpkins and squashes planted at any time produce good results. The fact that they are more hardy than other cucurbits makes them especially serviceable for this purpose, as they withstand insect attack better. As an example of the attractiveness of these trap crops, it should be stated that about 50,000 beetles were collected for experimental purposes from such crops in a few days during 1918 at the station of the Bureau of Entomology in Wisconsin.

THE USE OF INSECTICIDES.

ARSENICALS USED WITH ASHES, DUST, OR PLASTER.

A remedy frequently advised, when the beetles occur on low-growing plants, is to dust the majority of them with sifted wood ashes, road dust, or land plaster, and to spray or dust the remaining plants with lead arsenate, zinc arsenite, or calcium arsenate. The beetles concentrate on the sprayed plants, where they are killed by the poison; not always, however, before they have fed to such an extent that the plants will be more or less damaged.

ARSENATE OF LEAD.

Lead arsenate, which is in general use as the best remedy for the Colorado potato beetle and for chewing insects generally, has been tested against the striped cucumber beetle under different local and other conditions, and has proved the most effective insecticide for this insect. Arsenate of lead, as is well known, adheres to the plants better than Paris green; hence it is more useful where rains occur at the time of application. Where cucumbers are transplanted, as is done in some States, tests should be continued as to the value of insecticides and fungicides combined, and of arsenate of lead alone, as a dip for the plants before setting them out. It should be used at the weaker strength at first and afterward, if found desirable, at a greater strength; not, however, in excess of 2 pounds (dry or powder) in 25 gallons of water.

Arsenate of lead was used in 1907 at the New Hampshire Experiment Station, and later by the Bureau of Entomology at its stations in Indiana and Wisconsin, with the result that it gave the most efficient protection and injured the plants of cucumber and squash least of any of the several preparations tried. A spray of 1½ pounds (dry) has proved as successful as one of 6 pounds to 50 gallons of water.

In connection with arsenate of lead sprays the employment of trap crops is advisable. After the plants of the main crop begin to run, spray these with Bordeaux mixture, prepared according to the 4–4–50 formula.

Arsenate of lead has the following advantages over Paris green: (1) It contains less soluble arsenic and therefore is less harmful to young growing plants and when applied in the proper manner and at the correct strength does not scorch them; (2) it adheres more strongly to the foliage; (3) it is of greater value in that it leaves a white coating on the foliage, so that its presence, or absence, can be determined readily after spraying. When properly sprayed, treated plants have the appearance illustrated in figure 12.

The addition to the spray solution of the same weight of soap as of the arsenical used will render the spray more adhesive. The soap may be either resin fish-oil soap or laundry soap, preferably the former. The formula is as follows:

Arsenate of lead (powder)	pounds	3 or 1½
Soap for "sticker"	do	3 or 1½
Water, or Bordeaux mixture (2–4–50 formula)	gallons	50 or 25

FIG. 12.—Cucumber leaves sprayed with Bordeaux-arsenate of lead for protection against the striped cucumber beetle.

If the paste form of arsenate of lead is used, 3 pounds to 25 gallons of the liquid is the proper proportion. For small gardens use two-thirds of an ounce, or 10 level teaspoonfuls, of the powder to a gallon of water.

ARSENATE OF LIME.

Arsenate of lime, or calcium arsenate, is somewhat less effective than either lead arsenate or zinc arsenite, according to experiments of the Bureau of Entomology, but has given fair results in the control of the striped cucumber beetles and seems to be less distasteful to them than the other arsenicals. The beetles feed readily on foliage treated with this poison, and in view of the fact that several sprayings must be applied, its lower cost means a considerable sav-

ing. It is employed at the rate of 1 pound to 25 gallons of water, and may be purchased ready made from insecticide firms, or may be prepared at home as follows:

In a suitable container, such as a 50-gallon barrel, place 28 pounds of clear stone lime. Dissolve 50 pounds of sodium arsenate in boiling water, and use this solution while hot for starting the lime to slake. As slaking progresses add the remainder of the solution, taking care not to drown the lime, and stir the contents of the barrel vigorously with a hoe or other implement, to secure an even distribution of the poison. Continue the slaking, adding more water as necessary, until a total of 13 gallons, including that used in dissolving the sodium arsenate, has been used. The slaking should be active, to generate considerable heat and accelerate the chemical action.

After the arsenate of lime has cooled, a quarter-inch hole should be bored in the side of the barrel, one-half inch above the surface of the contents. The hole should then be plugged, the barrel nearly filled with water, and the contents again thoroughly stirred for about 5 minutes, in order to wash from the mixture the undesirable caustic soda formed in the chemical reaction. The material should then be allowed to settle over night, and the clear liquid on top drained off through the hole. This washing should be repeated once or twice, after which the poison is ready for use. The formula as given should provide about 180 pounds of paste arsenate of lime, at a cost of about 5 cents a pound.

One pound of this paste to 25 gallons of water makes a satisfactory spray for the striped cucumber beetle.

If kept covered with water and protected from freezing, the paste may be preserved indefinitely.

ZINC ARSENITE.

Arsenite of zinc, tested as a remedy for the striped cucumber beetle by the Bureau of Entomology at Plymouth, Ind., during 1918, and used at the rate of 1 pound to 40 gallons of water, gave nearly, but not quite as good results as arsenate of lead applied under the same conditions. As the cost of zinc arsenite is not materially less than that of arsenate of lead, at present quotations, there is no particular advantage in its use.

DRY ARSENICALS.

Arsenate of lead and other arsenicals, alone or mixed with plaster or lime dust in the proportion of from 1–20 to 1–50 by weight, and dusted over the plants, effectually protects them in many cases. As a general rule, however, spraying is more advantageous than dusting.

Precaution to prevent poisoning.—Lead arsenate and other arsenicals should be properly labeled and the word POISON should appear on the package. All poisonous substances should be kept under lock and key where children can not reach them.

Sprayers and all utensils employed in the preparation of lead arsenate and other poisons should be cleaned thoroughly after use.

BORDEAUX MIXTURE.

Bordeaux mixture, a combination of copper sulphate (bluestone) and stone lime or quicklime in solution, is a standard fungicide and a valuable repellent against certain leaf-feeding beetles. It also acts as a preventive of arsenical injury in spray mixtures. Its usefulness in the protection of cucumbers against the striped cucumber beetle warrants its employment in arsenical sprays against this pest. It may be prepared, according to the 4–4–50 formula, for home use as follows:

Provide two barrels, each of which should contain 25 gallons of water. Near the top of the water in one, suspend 25 pounds of copper sulphate in a burlap bag, allowing it to remain until dissolved. In the other slake an equal quantity of quicklime or stone lime. These form the stock solutions, in such proportion that a gallon of liquid contains a pound of the chemical.

After thorough stirring, pour 2 gallons of the copper-sulphate solution and 10½ gallons of water into a wooden container. In a similar container mix 2 gallons of milk of lime with 10½ gallons of water. Pour these together, into the sprayer tank, through a brass wire strainer of not less than 18 meshes to the inch, thus making 25 gallons of Bordeaux mixture.

If only small quantities of Bordeaux mixture are required, the commercial package product may be readily obtained from most seedsmen or druggists.

In forming a combination mixture of an arsenical and Bordeaux, the latter is simply substituted for the water and is used in exactly the same proportions.

DIRECTIONS FOR SPRAYING.

Two or three sprayings ordinarily will suffice for the overwintered beetles, and about the same number should be employed for the first new brood or generation. One or two sprayings for the second generation, where it appears, also should be given. The first spray should be applied *as soon as the plants come up*, and the other applications should be made at intervals of about a week, and just as the beetles of the first new brood appear and those of the second.

Applications of all poisonous preparations must be repeated when rainfall necessitates their renewal, until the plants have obtained a good start or the insects have dispersed. Arsenicals alone are not generally to be relied upon when the beetles are exceedingly numerous. One reason for this is that the beetles avoid the poisoned leaves and attack new growth or parts of plants which have not been covered completely by the spray mixture.

For success with any arsenical, every part of the plant must be coated—the upper and lower surfaces of the leaves and, above all, the vines and stalks, especially at the base—because when the beetles are abundant their feeding has the effect of girdling the plants near the base, even an inch under the surface of the ground.

In case Bordeaux mixture is sprayed or dusted on the plants as a protection against fungous diseases, an arsenical should be added. This protects the plants against leaf-eating insects in addition, at the mere cost of the arsenical.

SPRAYERS TO USE.

For spraying against the striped cucumber beetle a compressed-air sprayer of about 3 or 4 gallons capacity (see fig. 13) is considered the best for use in small gardens or in patches of from one-half acre to 2 acres, and is suitable even in somewhat larger fields, where labor is abundant and cheap. For larger fields, however, sprayers of the wheelbarrow or barrel type, handled by two men, are preferable. The method of applying the arsenical with a wheelbarrow sprayer is shown in figure 14.

In the case of the small grower who supplies pickles for pickling firms, the expense of a sprayer may seem excessive. If several growers will coöperate in the purchase of a suitable sprayer the individual expense will be small, considering the advantage that will be gained.

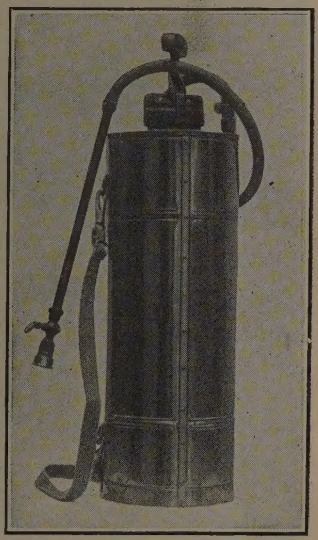

FIG. 13.—Compressed-air sprayer standing upright, showing hose, nozzle, and other attachments.

THE USE OF TOBACCO DUST AND LIME.

One of the oldest remedies, still in somewhat general practice and widely used by certain large commercial growers, consists in sprinkling the plants, when the soil is moist, with refuse tobacco or with a combination of tobacco dust and lime. Either substance deters the beetles from laying their eggs at the base of the plant, at least for a few days, thus permitting the plant to make sufficient growth to withstand serious injury by the beetles. Applications must be repeated frequently, especially if rain intervenes. In addition the tobacco acts as a mulch to the plants and as a fertilizer, but even with these the remedy is not so valuable as an arsenical.

DUST GUNS.

For dusting dry arsenicals or lime and tobacco dust nothing is better than a dust gun of a type similar to that shown in figure 15. Crude dusters such as a perforated tin can or muslin bag at the end of a pole can not be recommended, as it is impossible to secure an even distribution of dust by such methods.

STIMULATING GROWTH AND KEEPING THE PLANTS IN GOOD CONDITION.

Injury to the crop may be lessened by stimulating growth through generous applications of manure or commercial fertilizers and frequent cultivation, thus helping the plants to outgrow attack. In parts of the South ground fish or fish scrap is used as a fertilizer and is considered by many growers a useful deterrent of this and other insects attacking cucurbits.

Frequent watering of the plants, by irrigation or with a cart or hose, is of great value, especially during dry weather when they are seen to be wilting.

FIG. 14.—Spraying cucumbers with Bordeaux-lead mixture by means of wheelbarrow sprayer.

The plants should be examined carefully from time to time and kept free from the melon aphis, squash-vine borer, and other insect pests, as the aggregate injury to the vines by these pests renders the plants much more likely to succumb to the attacks of the cucumber beetle and of its larvæ at the roots.

PARTIALLY EFFECTIVE OR DOUBTFUL REMEDIES.

Pyrethrum insect powder, dusted on the plants with a powder bellows, is a fairly successful remedy when applied while the dew is on. This insecticide, however, is entirely too expensive for use on a large scale.

Naphthalene in the form of flakes or "camphor balls" has been tested as a deterrent for this and other cucumber-feeding insects, but as reports of results differ it can scarcely be recommended, especially since the present cost is almost prohibitive.

Arsenite of lime or calcium arsenite (not arsenate) can not be recommended as a spray without the addition of Bordeaux mixture, as it is likely to scald or burn the delicate foliage of young cucumber and related plants.

Land plaster or gypsum, as well as air-slaked lime, thoroughly saturated with kerosene or turpentine, was used as a repellent, with some success. The vapor is supposed to be particularly distasteful to the beetles, but as this vapor disappears in a short time it can scarcely be depended upon, especially in cases of extreme infestation.

Driving with air-slaked lime, a practice which was employed to a limited extent in the control of this pest, seems to be in the same category. While the beetles can be driven from the plants with the wind by dusting them with this preparation, they are likely to return, hence this can scarcely be advised as a remedy of importance.

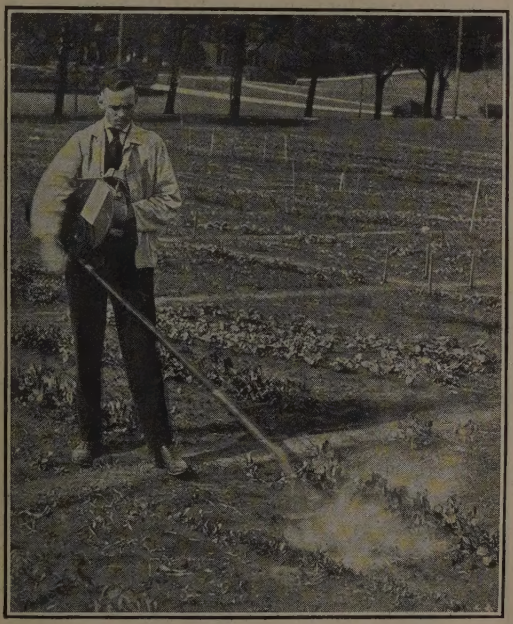

FIG. 15.—Applying lime and tobacco dust with a dust gun in the control of the striped cucumber beetle.

Early and late planting are of no value in themselves, but are useful when combined with other measures, and employed with special reference to the locality where the insect is injurious. Theoretically, transplanting from frames or hot houses early in the season will establish the plants so as to get ahead of the beetle, but in the principal cucumber regions there is danger from frost and in many localities it seems to be impossible to grow so early or so late that attack by the beetles can be prevented, as the beetles occur throughout the summer.

USELESS REMEDIES.

A number of proprietary remedies have been tried out with poor results. Such substances as charcoal, soot, road dust, land plaster, saltpeter, cow manure, and burdock infusion, supposed to repel the beetles, have not been effective, and hellebore is not a successful insecticide against the striped cucumber beetle.

REMEDIES IN BRIEF.

The arsenates of lead and of lime are deserving of more extensive use, that their value in control of the striped cucumber beetle may be demonstrated fully under all possible conditions. Among other remedies which give the greatest promise of success, preventives, repellents, and farm practice take a prominent place. To summarize, the principal control measures are as follows:

1. Protect young and choice plants in small gardens with coverings. These are useful only if the greatest care is observed to make them tight enough to keep out the beetles.

2. Plant an excess of seed to scatter attack. This should always be done.

3. Practice clean culture in connection with trap plants, such as beans, gourds, and early or late varieties of squash and pumpkin.

4. Spray with arsenate of lead, arsenate of lime, or zinc arsenite, alone or in combination with Bordeaux mixture, being careful to cover every part of the plant—both surfaces of the leaves, the vines, and the stems.

5. Keep the plants free from other insects and from disease.

6. Stimulate the growth of plants by manures or other fertilizers.

7. Water the plants in drought and in hot weather.

8. Cooperate with neighboring growers of cucurbits.

With the exercise of good judgment in planting, and by combined effort among growers of cucurbits over a considerable tract of country in the use of such of the remedies mentioned above as may be best adapted to local conditions, the total damage from the striped cucumber beetle should be greatly lessened.

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